INTERNSHIP REPORT

Date: 20 April, 2023

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Subject: **Internship Project Report**

Abstract:

A person can access the whole world at one go by using various forms of communication technologies. This paper focuses on exploring this new communication technology and give relative study on Li-Fi. In Li-Fi, from the electromagnetic (EM) frequency spectrum the visible light portion is used for information interchange which is analogous to conventional forms of wireless communication such as Bluetooth and Wireless- Fidelity (Wi-Fi), in which data or information is transmitted over the wireless medium using radio frequency (RF) signals. By modulating the intensity of light sources like LED is used as a transmitter and a photosensitive detector like Photodiodes (PD) is used for demodulation of the light signals to convert back into electrical form as a receiver. The intensity of light sources is modulated in such a way that which is unnoticeable to the human eyes. There is a crucial need of Li-Fi technology, to overcome the problem faced by the conventional wireless communication system. In this paper wide overview of need of Li-Fi, applications of Li-Fi, design challenges for Li-Fi, future scope and recent development in Li-Fi are provided. Keywords: Li – Fi, VLC, Photodiodes

Project Introduction:

The advent of smart phones, tablets, and many other devices has made mobile information access a central feature of our lives. It is estimated that more than 11 HEXA bytes of data traffic will be transferred through mobile networks every month by 2017, which pushes the radio frequency (RF) based wireless

technologies to their limits since the spectrum allocation chart has showed that most spectrum has already been allocated under license. In order to accommodate more users and more data traffic, several promising solutions have been proposed.
They can be classified into three groups:

- Exploring spatial resources to improve spectrum utilization,
- Establishing heterogeneous networks (Het-Net) with small cells to reuse bandwidth,
- Searching for more available spectrum resources, such as millimeter waves or wireless optical bandwidth.

Among the above possible solutions, visible light communication (VLC), which uses wireless optical in the wavelength interval of 380–780 nm has received much research interests recently. The first wireless communication prototype using visible light was far back as 1880, when Alexander Graham Bell developed a photo-phone that allowed for the transmission of both sounds and normal human conversations on a beam of light.
However, the Research of optical wireless communication did not receive much attention for several years. As the development of the semiconductor technology, this situation has been changed. It is possible that visible light communication (VLC) uses off-the-shelf white light emitting diodes (LEDs) as signal transmitters and off-the-shelf p-intrinsic-n (PIN) photodiodes (PDs) or avalanche photo-diodes (APDs) as signal receivers.
VLC not only provides indoor illumination but also offers broadband connectivity by modulating information onto the intensity of the light. Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow.
Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication.
"At the heart of this technology is a new generation of high brightness light-emitting diodes", says Harald Haas from the University of Edinburgh, UK" Very simply, if the LED is on, you transmit a digital 1, if it's off you transmit a 0," Haas says, "They can be switched on and off very quickly, which gives nice switched on and off very quickly, which gives nice opportunities for transmitted data". In sample terms, Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information.
And instead of Wi-Fi modems, Li-Fi would use transceiver-fitted LED lamps that can light a room as well as transmit and receive information. Since simple light bulbs are used, there can technically be any number of access points.

LITERATURE REVIEW

a) NEED OF Li-Fi:

Most of us are familiar with Wi-Fi (Wireless Fidelity), which Uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places. We have become quite dependent upon this nearly ubiquitous service. But like most technologies, it has its limitations.

While Wi-Fi Can cover an entire house, its bandwidth is typically limited to 50-100 megabits per second (Mbps) today using the IEEE802.11n standard.

This is a good match to the speed of most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games. The more we become dependent upon „the cloud" or our own „media servers" to store all of our files, including movies, music, pictures and games, the more we will want bandwidth and speed. Therefore RF-based technologies such as today's Wi-Fi are not the optimal way.

In addition, Wi-Fi may not be the most efficient way to provide new desired capabilities such as precision indoor positioning and gesture recognition. Optical wireless technologies, sometimes called Visible light communication (VLC), and more recently referred to as Li-Fi (Light Fidelity), on the other hand, offer an entirely new paradigm in wireless technologies in terms of communication speed, flexibility and usability.

Professor Harald Haas, from the University of Edinburgh in the UK, is widely recognized as the original founder of Li-Fi. He coined the term Li-Fi and is Chair of Mobile Communications at the University of Edinburgh and co-Founder of pure LiFi.

The general term visible light communication (VLC), includes any use of the visible light portion of the electromagnetic spectrum to transmit information. The D-Light project at Edinburgh's Institute for Digital Communications was funded from January 2010 to January 2012. Has promoted this technology in his 2011 TED Global talk and helped start a company to market it. Pure LiFi, formerly pure VLC, is an original equipment manufacturer (OEM) firm set up to commercialize Li-Fi products for integration with existing LED-lighting systems.

In October 2011, companies and industry groups formed the Li-Fi Consortium, to promote high-speed optical wireless systems and to overcome the limited amount of radio based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum.

A number of companies offer unit directional VLC products which is not the same as Li-Fi. VLC technology was exhibited in 2012 using Li-Fi. By August 2013, data rates of over 1.6 Gbps were demonstrated over a single-color LED. In September 2013, a press release said that Li-Fi, or VLC systems in general, do not require line-of-sight conditions. In October 2013, it was reported Chinese manufacturers were working on Li-Fi development kits.

Li-Fi technology uses a part of the electromagnetic spectrum that is still not greatly utilized. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover, there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally.

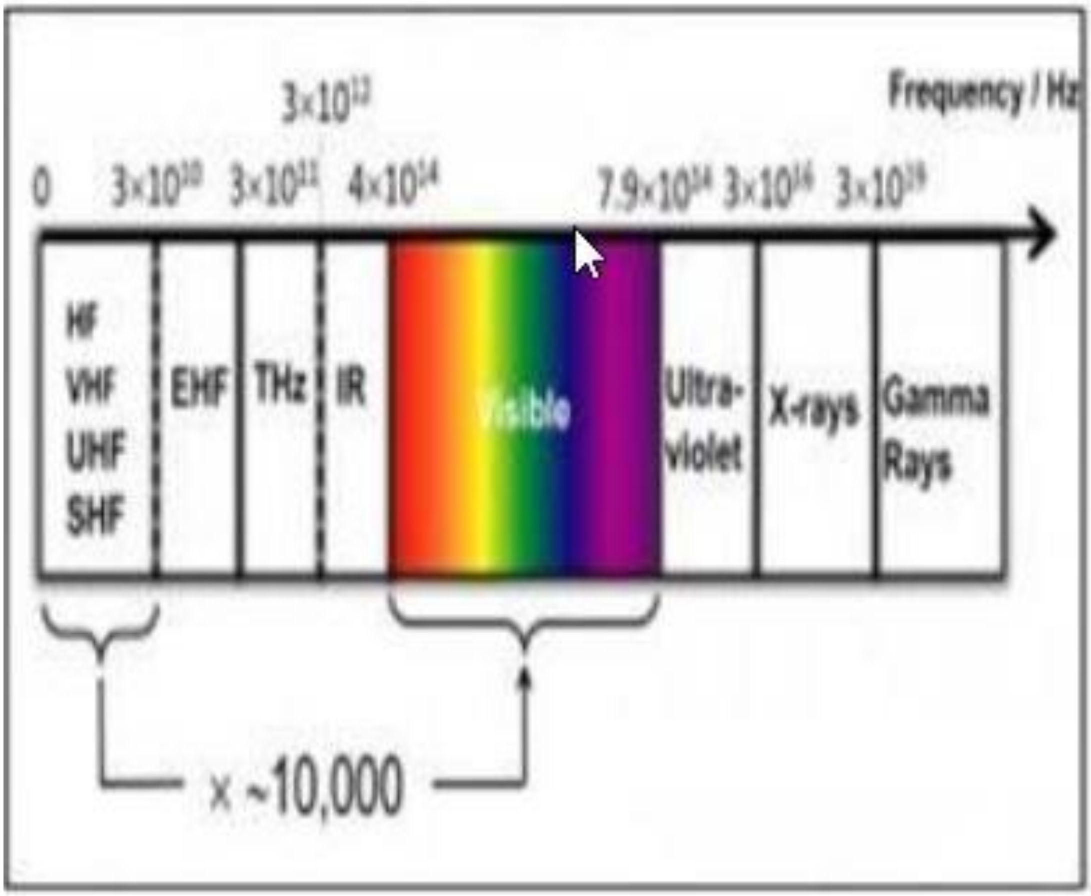

Fig. 3: - The visible spectrum

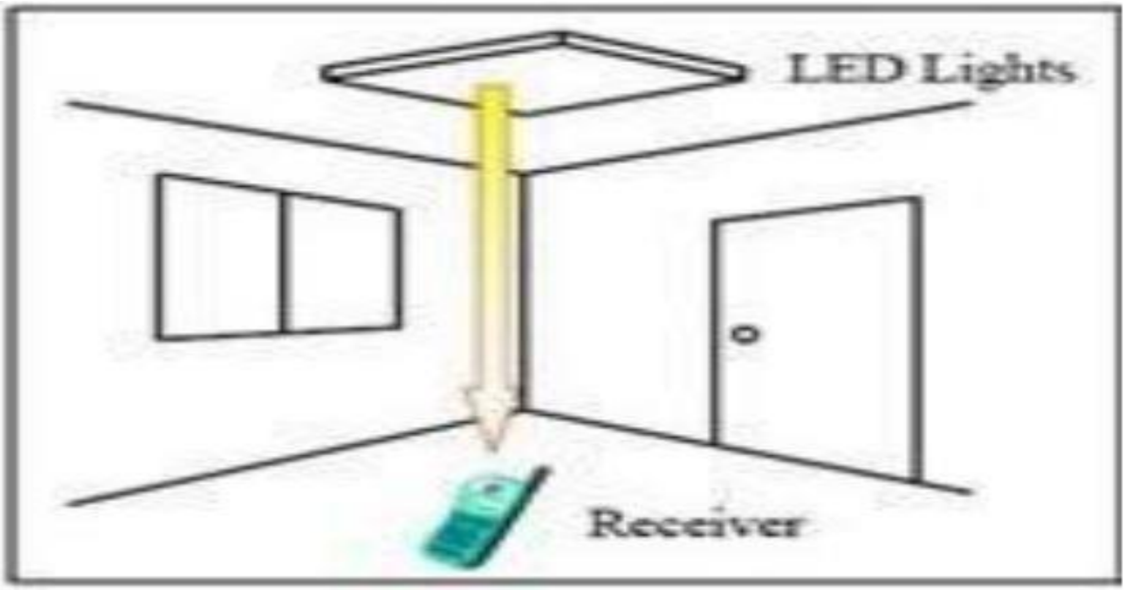

Fig. 1: - Use of LED illumination as a transmitter

Fig. 2: - Li-Fi integrated conference rooms

b) **Li-Fi MODULATION TECHNIQUES**:

Unlike RF modulation methods, VLC adopts the intensity modulation to carry binary data by turning LED on and off quickly, in which the amplitude and phase information are lost. Besides, modulation is a critical challenge for VLC since it directly affects the illumination quality, which will potentially lead to human health complications, such as nausea or epilepsy, related to fluctuations in light intensity. For fulfilling user satisfaction, dimming and illumination are the first concerns for the VLC design. For the VLC transmitter LED, dimming can be obtained by controlling the drive current because the LED junction current is proportional to the brightness. Analog dimming, which adjusts the current continuously, is the simplest type of dimming control. However, it will affect the emitted light wavelength to bring the chromaticity shift problem. To this end, digital dimming schemes are proposed. They can be achieved by adjusting the average duty cycle or signal density, thus producing the same average LED drive current. Furthermore, the time average power from an LED should not be lower than a threshold value defined by the dimming factor. Pulse position modulation (PPM) encodes information by transmitting a pulse in different time shifts. Each slot contains a unique bit combination for each symbol. Therefore, the average power is constant with time, which solves the flicker problem. A modification to this PPM technique is called the Variable-PPM (VPPM), which is proposed in the IEEE 802.15.7 standard for VLC. It uses binary PPM to send data and changes the pulse-width to control the dimming level. Another feasible VLC modulation technology is to control the width of the pulse based on the signal information which is known as pulse width modulation (PWM). Considering the efficient dimming control, multi-path PWM (MPWM) has been proposed, in which multiple LEDs are used and the average current through each LED array is pulse width modulated. In order to increase power and spectral efficiency, multiple PPM (MPPM) is proposed that the transmission symbol. On-off keying (OOK) is presented to satisfy arbitrary dimming and code rate requirements.

FEATURES OF LI-FI

Li-Fi features include benefits to the capacity, energy efficiency, safety and security of a wireless system with a number of key benefits over Wi-Fi but are inherently a complementary technology.

a) Capacity:

• Bandwidth: The visible light spectrum is plentiful (10,000 more than RF spectrum), unlicensed and free to use.

• Data density: Li-Fi can achieve about 1000 times the data density of Wi-Fi because visible light can be well contained in a tight illumination area whereas RF tends to spread out and cause interference.

• High speed: Very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output.

• Planning: Capacity planning is simple since there tends to be illumination infrastructure where people wish to communicate, and good signal strength can literally be seen.

b) Efficiency:

• Low cost: Requires fewer components than radio technology.

• Energy: LED illumination is already efficient and the data transmission requires negligible additional power.

• Environment: RF transmission and propagation in water is extremely difficult but Li-Fi works well in this environment. c) Safety:

• Safe: Life on earth has evolved through exposure to visible light. There are no known safety or health concerns for this technology.

• Non-hazardous: The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments. d) Security:

• Containment: It is difficult to eavesdrop on Li-Fi signals since the signal is confined to a closely defined illumination area and will not travel through walls.

• Control: Data may be directed from one device to another and the user can see where the data is going; there is no need for additional security such as pairing for RF interconnections such as Bluetooth

APPLICATIONS OF LI-FI

The applications of visible light communication to location-based services and new graphical user interfaces that combine visual imagery with visible light communication have potential widespread use. For these applications, users are able to know the information associated with a transmitter. If a transmitter is attached to a building or a fixed place, location information will be obtained.

a) Indoor Navigation:

A typical application of visible light communication for location-based services is where a user uses a cellular phone with a photo diode, which detects signals from an LED light. This application is especially useful indoor because GPS receivers do not work well indoors even though they work well outdoors.

Fig. 4: - Indoor Navigation using Li-Fi (JAPAN)

b) **Indoor Navigation for visually impaired people**:

Indoor navigation is convenient for everyone, and it is especially indispensable for the visually impaired. Such a navigation system can be proposed for the visually impaired as shown in Fig. LED lights emit visible light with location data and a smart phone with visible light receiver receives the data. The smart phone calculates the optimal path to a designation and speaks to the visually impaired through a headphone.

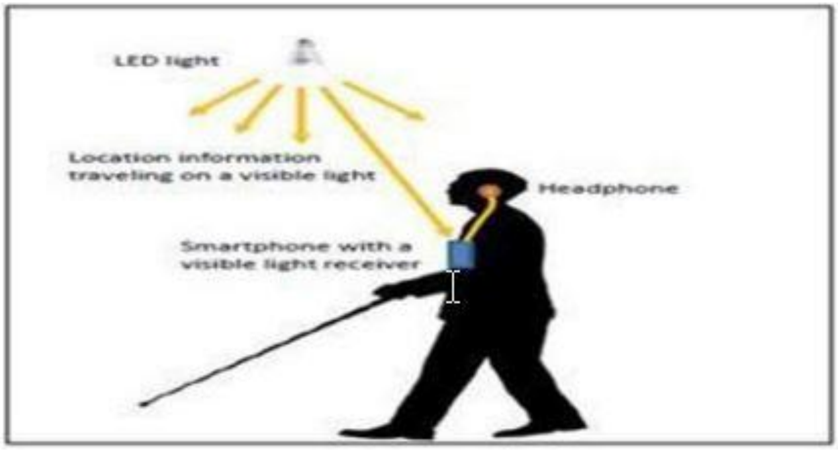

Fig. 5: - Indoor Navigation for visually impaired people

c) **Visible Light Communication using Image Sensors as Receivers:**

An image sensor continuously takes images of a scene with an LED light whose light intensity is modulated and a receiver detects the optical intensity at a pixel where the LED light is focused on. Image sensors used for digital cameras or video cameras usually have frame rate of tens of frames per second. The data associated with a user is sent from the LED transmitter and an image sensor detects not only its direction of a transmitter in an image, but also its received data contents. The monitor displays its contents at a location in an image where the data is sent from

d) **Vehicle to Vehicle Communication using Li-Fi:**

As light frequency spectrum is huge, it is beneficial to be adopted in a short-range wireless communication. Thus, it provides cost effective yet inexpensive mechanism for vehicle communication through the use of an optical wireless communication medium, the effective solution to reduce accidents. The block diagram of the system is shown in fig.9. The functionality of the building blocks of the system is described next. The data source e.g. (speed sensor) reads the speed of the vehicle. The speed data from the sensor is peak to peak AC voltage so it will be converted to DC voltage to be readable by the microcontroller. Then the data will be processed by microcontroller (e.g., to compare between the current and previous speed). New processed data will then be transmitted to the LED driver. LED driver will make the current constant to protect LED. Then, data will transmit by the LED light as carrier. Upon data transmission wirelessly through light, the photodiode will detect the transmitted light in form of current. Trans-impedance amplifier function is used to convert the received current into voltage. Finally, voltage will be processed through microcontroller to be readable by the LCD.

FUTURE SCOPE

a) **Airways:**
Whenever we travel through airways we face the problem in communication media, because the whole airways communications are performed on the basis of radio waves. To overcome this drawback on radio ways, li-fi can be introduced.

b) **You Might Just Live Longer:**
For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of computers cans block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms.

c) **Increase Communication Safety**:
Due to visual light communication, the node or any terminal attach to our network is visible to the host of network.

d) **Multi User Communication:**
Li-Fi supports the broadcasting of network, it helps to share multiple thing at a single instance called broadcasting.

e) **Smarter Power Plants**:
Wi-Fi and many other radiation types are bad for sensitive areas. Like those surrounding power plants. But power plants need fast, inter-connected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. The savings from proper monitoring at a single power plant can add up to hundreds of thousands of dollars. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. Not only would this save money related to currently implemented solutions, but the draw on a power plant’s own reserves could be lessened if they haven’t yet converted to LED lighting

Duties Performed:

Conducting experiments:

Researchers may need to design and conduct experiments to test hypotheses and validate new concepts related to LiFi technology. This could involve setting up experimental setups, collecting and analyzing data, and interpreting the results.
In the working duration I performed various experiment with my senior project engineer to carry out needed outcome values. Done Wi-Fi and Li-Fi metrics and compare the outcome in different scenarios and also doing hybrid testing of the Li-Fi and Wi-Fi whenever user switch between Li-Fi and Wi-Fi handover happens between both.

Case Study:

- Wi-Fi and Li-Fi with single user.

Li-Fi Access Points for sending data packets in form of light photons.

Li-Fi Dongle for receiving data packets in form of visible light.

- Wi-Fi to Li-Fi with two users.
- Wi-Fi to Li-Fi with three users.

Preparing documentation:

During every experiment we prepared the metrics in various graphical and statistical format and also prepared PPTs for the showcasing the what we have done. For each experiment we have to write data rates of data send by Li-Fi access point to receiver dongle during each handover from Wi-Fi to Li-Fi whenever user switch between both.

Learnings:

- Linux Operating System
- Manual Testing of Hybrid Li-Fi and Wi-Fi.
- Experimentation
- Electronics Components and Sensors
- Documentation
- Presentation
- Team Work
- Corporate Etiquette
- Communication